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Investigating Factors Influential on the Success of Social Product Development initiatives

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Abstract

Social Product Development (SPD) is represented by tenants including crowdsourcing, open innovation, cloud-based design and manufacture (CBDM) and mass collaboration that either individually or in concert contribute to the democratization of design, manufacture and innovation. Although widely and very successfully used in thousands of documented case studies [1], these tenants have not yet fully arrived within the domain of professional and commercial industrial product development. Amongst the reasons for this are a lack of clear definitions as to what these tenants are and clear guidelines or procedures that outline how they can be used to aid the various phases of the product development process. In this paper, the authors investigate how success for each of the tenants or any combination thereof can be influenced. The tenants of Social Product Development can be mapped according to three factors; proximity to other participants (P_a), proximity to leading organization (P_o) and the number of participants (N). In this paper, the authors hypothesize that these three variables are related to the success of SPD tenants. An analysis study is then conducted with expert researchers to test this hypothesis and determine whether these variables are influential on SPD success. The expert researchers determined that only one relationship, between open innovation success and organizational proximity existed, therefore rendering all other relationships non-existent and disproving the hypothesis. Results and limitations of the study are discussed before aims for further research are highlighted. These include clarifying definitions of success for Social Product Development, providing success factors for the tenants and supporting practitioners in applying SPD tenants.

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Keywords: social product development; open innovation; crowdsourcing; open source; collaborative design

1. Introduction

Social Product Development (SPD) is defined as a group of "coalescing tools and socio-technologies" represented by several tenants including crowdsourcing, mass collaboration, open innovation and cloud-based design and manufacture (CBDM) [1]. Existing examples of Social Product Development have resulted in enhanced collaboration in design teams, shorter lead times and significant reductions in R&D costs. Despite these potential benefits, guidance on how to conduct Social Product Development is lacking in existing literature and the use of Social Product Development tenants in industry is limited. As stated by Piaget [2], defining and measuring success, results in the "legitimization of 'know-how', and 'understanding' as a characteristic of conceptualization". In order to increase understanding and guidance on the application of SPD, the authors therefore seek to define metrics of success for Social Product Development.

Existing literature on Social Product Development success exclusively considers methods for organising social actors and information. Abhari et al. [3] presents a "classification model to predict social actors' co-innovation behaviour in social product development". Abhari et al. suggest that classifying and organising social actors is "beneficial in expanding (Social Product Development) for practical application" [3]. Similarly, Markopoulos et al. [4] present the "structure, concepts, methods and operations of a proposed framework that addresses" this new approach to product development. They

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describe SPD as "co-evolution of a democratic industry-society relationship between the large or small organizations and individuals" [4]. Abhari et al. [5] also focus on actor behaviour as a key to defining SPD success stating that "predicting co-creators' behavioural intentions" is critical for understanding the co-creation experience. Authors that specifically refer to social product development success therefore focus on the organisation of SPD actors with the assumption that better organization leads to success. Specific definitions of success and what success means in the context of Social Product Development, however, are not discussed.

Definitions of success are presented more clearly in existing literature of individual tenants. With regards to crowdsourcing, Panchal [6] defines "modes of crowdsourcing failure" including poor quality of solutions and cost exceeding that of an in-house team. With regards to open innovation, Westergren [7] defines success according to the strength of "inter-organizational relationships" and for cloud-based design and manufacture, Bohlouli et al. [8] defines "availability and access to knowledge" as a mark of success. Despite definitions, general metrics of success are omitted. Authors have included metrics of success when SPD tenant outcomes can be directly compared to outcomes of traditional product development practises, however, these are specific to the application. Existing literature therefore fails to provide metrics for SPD success.

The research aim for this paper is to propose and investigate influential factors for SPD success. Factors for SPD success must recognise common characteristics of the tenants, how they are related and how they represent Social Product Development. The following section represents this process and results in the mapping of each tenants according to three common variables. A hypothesis is then proposed that presents these variables as factors of SPD success. The results of an analysis study, designed to test this hypothesis is then presented, with the paper concluding with a discussion of the results, limitations of the study and future research avenues.

2. Proposing SPD Factors for Success

Each of the Social Product Development tenants are related by and can be distinguished by three core variables. These variables are actor proximity (P_a), organizational proximity (P_o) and the number of participants (N). As described by Abhari et al. [5] the involvement of external participants and how they relate to both each other and the leading organization is integral to Social Product Development success. In Table 1, these variables are defined. Actor proximity and organizational proximity have been allocated an arbitrary scale, allowing the tenants to be mapped and distinguished from each other.

Table 1. Three core variables of SPD.

Variable	Scale	Interpretation
Organisational proximity, P_o	1 - 10	1 = the actor or involved party is an external organisation that has minimal knowledge beyond what is in the public domain 5 = the actor or involved party is within the same industry as the organisation 10 = the actor or involved party is within the same organisation but not within the same location as the project lead (Web 2.0 technologies are therefore required for involvement)
Actor proximity, P_a	1 - 10	1 = the actors or involved parties do not have a relationship and do not collaborate with each other 10 = the actors or involved parties are within the same organisations each other and have at least professional relationships with each other
Number of participants, N	1 - ∞	This refers to the number of people involved in the activity or the number of people with the opportunity to be involved in the activity

Table 2 shows the values for each variable. In Figure 1 below each SPD tenant has been mapped according to these variable values. The number of participant (N) is shown on the y axis, actor proximity (P_a) is shown on the x axis and organizational proximity (P_o) is shown on the z axis.

Table 2. Analysis Experiment Participant Sheet.

SPD Tenants	P_a	P_o	N
Crowdsourcing	1 - 5	1 - 5	25 - ∞
Open Innovation	1 - 5	1 - 5	25 - ∞
Cloud-Based Design and Manufacture	1 - 10	1 - 10	1 - ∞
Mass Collaboration	1 – 10	1 - 10	25 - 100

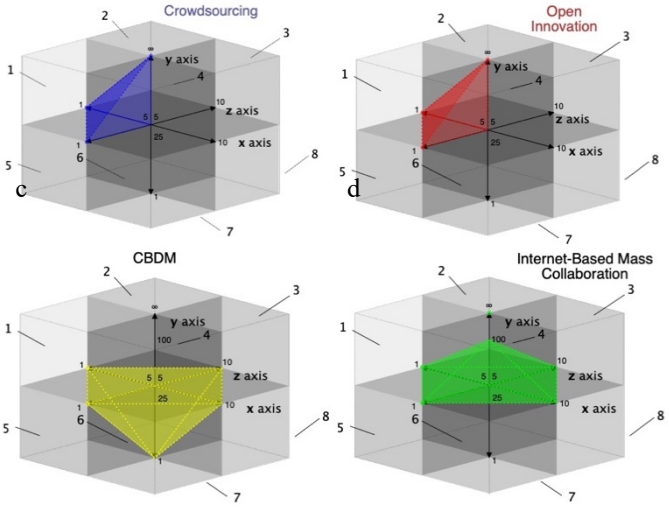

Fig. 1. Mapping SPD tenants according to the three variables; (a) Crowdsourcing; (b) Open Innovation; (c) Cloud-Based Design and Manufacture; (d) Mass Collaboration.

Having proposed these three variables and demonstrated how each of the SPD tenants can be represented by them, a hypothesis is presented.

2.1. Hypothesis

If these variables can define and describe the different tenants of SPD, they can be used to assess the performance of these variables.

3. Expert Analysis Experiment

3.1. Experimental Methods

In order to test the hypothesis, an experiment was conducted to determine whether existing understanding of tenant success encompassed or was related to one or any of the variables. Factors of success for crowdsourcing, open innovation, cloud-based design and manufacture, and mass collaboration are yet to be presented in these relatively new research fields, however, so definitions of success were instead used.

Definitions in existing literature are regularly used in design research to represent a consensus of understanding of a term [9]. For example, Han et al. [10] use definitions of creativity in design to understand the relationship between functionality, aesthetics and creativity. Vital in this approach, however, is the use of a large number of definitions from leading journals in the field. Using Scopus, Web of Science and ScienceDirect as literature databases, keywords such as "crowdsourcing success" and "success in crowdsourcing" were used to yield 63 "statements of success". These statements were identified from existing literature as describing conditions or requirements for success for each tenant. Example success statements from each tenant are shown in Table 3.

Table 3. Example Success Statements.

SPD Tenant	Example Success Statement
Crowdsourcing	We suggest workers working collaboratively develop better crowdsourcing solutions
Open Innovation	Open innovation success is dependent on knowledge sharing with external participants
CBDM	For cloud-based design and manufacture success customer expectations must be considered
Mass Collaboration	Individual personality traits influence mass collaboration success

To determine whether these success statements described a relationship between the success of the tenant and any of the variables, expert researchers were asked to tick any or none of the variables associated with the success statement. This survey is shown in Table 4. The use of expert researchers in similar analysis exercises is common in design research with authors such as Sarkar and Chakrabarti [11], Chulvi et al. [12] and Cropley and Kaufman [13] using multiple expert researchers to establish an expert consensus in similar experiments.

Table 4. Analysis Experiment Participant Sheet.

Success Statement	P_a	P_o	N
We suggest workers working collaboratively develop better crowdsourcing solutions.			
Open innovation success is dependent on knowledge sharing with external participants.			
For cloud-based design and manufacture success customer expectations must be considered.			
Individual personality traits influence mass collaboration success.			

Expert researchers were asked to tick the corresponding box if they thought the success statement related to the variable. Multiple variables or "None" could be selected for each success statement.

3.2. Experiment Process and Results

Five expert researchers, with a mean age of 29.6 (Standard Deviation (*SD)=4.0*) and a mean research experience of 4 years (*SD=0.6*), were involved in this analysis experiment. The experts participated in the evaluation voluntarily with intrinsic motivations [10]. Although the number of experts seems low, there are no common agreements on the number of experts required for an evaluation [14]. Comparing with general evaluators, the required number of expert evaluators is far less [15].

To determine whether a variable was related to the success of a tenant, each success statement was given a "relatability metric" for each variable. This metric represented the number of researchers that marked the variable as relating to the success statement. For example, if 3 researchers deemed the variable to be related to the success statement, a value of 0.6 was listed. These values were then averaged across all success statements for each tenant. According to List [16], a value of 0.75 or above is required to indicate expert consensus. Table 5 below shows that the expert researchers determined only one relationship, of the nine tested, to represent a consensus (*). The expert researchers determined open innovation success to be related to organizational proximity (P_o) but determined no other relationships between tenant success and three variables as outlined in the hypothesis.

Table 5. Relatability metric results for each tenant and variable.

SPD Tenant	Relatability Metric		
	P_a	P_o	N
Crowdsourcing	0.186	0.243	0.286
Open Innovation	0.156	0.756*	0.011
CBDM	0.108	0.215	0.123
Mass Collaboration	0.4	0.313	0.075

To determine internal consistency in the expert researchers results, Fleiss' Kappa coefficient was used. Fleiss' Kappa is a generalization of Scott's pi statistic [17], a statistical measure of inter-rater reliability and works for any number of raters giving categorical ratings, to a fixed number of items. To calculate Fleiss' Kappa all possible outcomes must be mutually exclusive. If one researcher marked the statement as relating to P_a and another marked the statement as relating to P_a and P_o this was marked as a disagreement with "P_a" and "$P_a + P_o$" being listed as two mutually exclusive events. Fleiss' Kappa

coefficient is calculated using Equation 1 below and Table 6 shows the results for each tenant.

$$Kappa, \kappa = \frac{\bar{P} - \bar{P_e}}{1 - \bar{P_e}} \quad (1)$$

Table 6. Fleiss' Kappa for the results of each tenant.

SPD Tenant	$\bar{P}$	$\bar{P}_e$	κ
Crowdsourcing	0.736	0.253	0.646◊
Open Innovation	0.816	0.463	0.657◊
CBDM	0.646	0.380	0.429♦
Mass Collaboration	0.671	0.291	0.535♦

Fleiss' Kappa is interpreted according to Table 7 below by Landis and Koch [18]. This defines the internal agreement between assessors as above moderate agreement for all tenants and substantial agreement for crowdsourcing and open innovation.

Table 7. Interpretation of Fleiss' Kappa [18].

κ	Interpretation
< 0	No agreement
0.01 < κ < 0.20	Slight agreement
0.21 < κ < 0.40	Fair agreement◊
0.41 < κ < 0.60	Moderate agreement♦
0.61 < κ < 0.80	Substantial agreement
0.81 < κ < 1.00	Almost perfect to perfect agreement

4. Discussion

The results show that only one relationship, between open innovation and organizational proximity (P_o), was defined by consensus by the researchers. All other relationships were deemed non-existent by at least three out of five assessors. These results were supported by moderate (0.4<k<0.6) and substantial agreement (0.6<k<0.8). This means that in the case of the Crowdsourcing and Open Innovation success statements, the researchers agreed in more cases than not that they did not represent the tested factors. In the case of CBDM and Mass Collaboration, the researchers agreed in the significant majority of cases that the success statements did not represent the tested factors. These results therefore disprove the hypothesis and suggest that organizational proximity (P_o), actor proximity (P_a) and the number of participants (N) are not influential in the success of Social Product Development (SPD) tenants.

A reason for these results could be due to the fact that most success statements focused on the outcomes as defining success as opposed to the dynamics of an SPD initiative and how that initiative was regarded as a success as a consequence. This is perhaps reflective of an existing approach to SPD tenants, by considering them as a "means to an end" without considering the design of the SPD initiative to influence the outcome.

The use of "success statements" for this experiment could have also led to these results by introducing several uncertainties. In the absence of success factors, definitions of success are often consolidated and used as a replacement [9]. In the case of this emerging field, however, definitions are often inconsistent and ambiguous. For example, Striukova and Rayna [19], define "increasing involvement" as a factor for success in open innovation. While expert researchers, offered substantial agreement on this statement, "involvement" could refer to effort by existing participants or "increasing" number of participants.

The results indicated a relationship between open innovation and organizational proximity (P_o). The authors suggest that this result emerged from a consistent theme among open innovation success statements that included references to organizational relationships. Based on the limitations discussed in this section, to truly establish whether this relationship exists, further research into this relationship should be conducted.

As well as ambiguity in the resulting "success statements", existing literature presented different interpretations and perspectives on success that were inconsistent. For example, Warner [20] states that "most critical crowdsourcing success is that participants felt their input was considered and acted upon" while Westergren [7] states "defined roles within an organization" is vital to open innovation success. It was therefore not only differing opinions on the factors for success but differing opinions on from what perspective success should be determined. Furthermore, with open innovation literature, some authors described creating a "successful open innovation environment" as opposed to "successful outcomes of open innovation". In addition, while most statements considered dynamics of the tenants that influenced success, in some cases, particularly within CBDM, "practical" aspects such as "reduce latency" were presented which were not within the realm of success factors originally considered or accounted for by the authors. Furthermore, while the authors aimed to ensure the success statements could be interpreted outside of the context of their origin, it may have been the case that a lack of context could result in different interpretations of the statement. The key issue is that, with work on SPD tenants in its infancy, the definitions of "SPD success" are still emerging and it could be said that this experiment should be conducted when success definitions are more widely known and used.

These definitions of success also encourage further consideration of the term SPD and whether tenants of differing dynamics can be usefully grouped and studied under one term. As defined in this paper, Social Product Development tenants either individually or in concert contribute to the democratization of design, manufacture and innovation. The authors questions whether the broad subject of Social Product Development can be investigated when individual tenants, as demonstrated by definitions of success, vary significantly. It is considerations such as this which encourage deeper research to develop the field of individual tenants as opposed to consider Social Product Development as a whole.

4.1. Limitations

Despite adequate agreement to validate the results, more expert researchers would improve the value of these results.

Furthermore, the standard deviation of the experience of the participants (*SD=0.6*) showed a limited variety of experience levels which is another limitation to these results. Furthermore, while years of experience is not a strict measurement of expertise, an average experience level of 4 years is considered low in comparison within other design research [12]. Increasing the number of design experts, varying levels of expertise with a higher average level of expertise, limit the results of this study.

Another limitation refers to the interpretation of Fleiss' Kappa [17] by Landis and Koch [18]. While this is most widely used to interpret Fleiss' Kappa results, it has been criticized for inaccuracies in the case of more than three variables [21]. While the study included three variables, the ability to answer with multiple variables led to more than three mutually exclusive events for testing agreement. In general, academics suggest that agreement interpretation for larger variables is too harsh with the Landis and Koch interpretation [21]. It is therefore the case that, if adjusted for the inconsistencies, these results would demonstrate higher agreement and the reliability of the results would not be compromised.

Finally, the success statements were collected exclusively from literature relating to the SPD tenants and therefore exclusively used this terminology. This was done to ensure consistency within the scope of the analysis study. It is the case, however, that other research areas within design will contain other success statements relating to the SPD tenants. For example, extensive research within "collaborative design" may inform the success factors for "mass collaboration" and success statements for "open source" may inform success factors for "crowdsourcing". These success statements were not included to limit length and complexity of the study for participants but may provide additional findings in future work.

4.2. Further Work

Definitions of success for each tenant are complex but understanding the dynamics of success could allow the design industry to capture the benefits of Social Product Development. To demonstrate the complexity of the dynamics of SPD success, crowdsourcing is considered successful when it has lots of high-quality solutions. However, if there are too many solutions, the cost of evaluation may cause the initiative to be more expensive than an in-house team. This then defines the crowdsourcing initiative as a failure [6]. Valuable further work, relating to each of the tenants, could include investigating the dynamics for success then supporting practitioners in making effective design decisions.

Furthermore, designing SPD tenants has been proven important in extracting value from external participants [6] but limited research exists in this area. Striving to create success factors for Social Product Development should be supported by frameworks to aid the methodical design of SPD tenant initiatives. Designing SPD tenant initiatives involves a series of decisions such as which communication platform to host a crowdsourcing contest on or the incentivization of involvement in an open innovation initiative. Recognition of this decision-making process as well as an understanding of how these decisions impact the success of an SPD tenant initiative will support practitioners in capturing the benefits of applying Social Product Development.

5. Conclusions

Existing literature is yet to present factors for success for Social Product Development Tenants. In this paper, three variables were presented and proposed as factors for success; actor proximity (P_a), organizational proximity (P_o) and number of participants (N). To determine whether these variables were related to success, a study was conducted with expert researchers analyzing SPD tenant "success statements". The results showed that only one relationship; organizational proximity and open innovation reached the 0.75 relatability metric required to indicate researcher consensus. The researchers showed moderate to substantial agreement, therefore indicating the results were reliable. As a consequence, the three variables were deemed to not be adequate factors for SPD tenant success. As well as offering insights into the best approach for allocating success factors for SPD, this study also raises the challenge of studying a term representative of four very different tenants. This study also demonstrates the limitations of using definitions of success for analysis in an emerging field and the need to simultaneously develop design frameworks to support methodical design of SPD tenants as well as establish success factors.

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